

Research Essay

Of Time & Experience

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Abstract

The aim of this paper is to unpack the aphorism that reality is comprised of “actual occasions of experience” and see what conclusions can be drawn. It is proposed that ‘actual occasions’ are the totality of outcomes of quantum energy ‘measurements’, while ‘experience’ may be a term for the durational reciprocity of measurement processes. Implications of these attributions for cosmological dynamics are identified, followed by a discussion of their possible relevance to brain dynamics and associated experience. The principal conclusion is that refining this set of ideas might best be achieved through study of both apparent experiential anomalies and mind-associated physical anomalies.

Keywords: Cosmology, duration, dynamics, energy, experience, memory, phenomenology, time.

1. Introduction

The ambition of many theorists - “to consider coherent models based on a minimal number of assumptions” (e.g. ANPA 2016) - was taken to an extreme 100 years ago by Alfred North Whitehead (1922) in developing his aphorism that reality is the totality of “actual occasions of experience”. This might reasonably be viewed as a suggestion on a par with Deep Mind’s conclusion (in Douglas Adam’s ‘Hitchhiker’s Guide to the Galaxy’ – not given by Google!) that “the answer to the meaning of life, the universe and everything is 42”. The aim of this paper however is to suggest that, if ‘actual occasions’ are treated as endowments of causative events with durational existence, then potential implications are a lot more interesting than those of ‘42’. The ‘experience’ referred to in the aphorism can then be treated as the reciprocity between measured and measurer that is always involved in quantum measurements, whether conceived in terms of decoherence theory or any of the concepts of ‘wave function collapse’ or ‘state vector reduction’ that have been offered, ranging from von Neumann’s take on the standard Copenhagen interpretation to ‘transactional’ extremes.

Exploration of these implications requires adoption of a few, I hope uncontentious, ground rules:

- (a) Durational existence, in the sense of acquisition of fourth dimensionality, has its origins in the ‘quantum measurements’ which result in decoherence/wavefunction collapse/ state vector reduction and translate probabilistic into definite, determinate outcomes.

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- (b) Although position in space is included among probabilities encoded in wave functions, position in time is not; it's an essentially Newtonian 'rule' enabling description of the very existence of wave functions along with some of the gauge (Yang-Mills) theoretical consequences.
- (c) As special relativity tells us, photons traversing the vacuum have no inherent durational existence despite owning a nominal frequency. The appearance of durational existence (the 't' metric) relating to them is a function of causal events that they mediate.

Given these ground rules there are obvious questions to ask about the nature of durationality which is treated in relativity theory as a temporal 'distance' analogous to spatial distances (albeit of the opposite sign when squared); a linear property to which the machinery of infinitesimal calculus can properly be applied. Quantum theorists might want to substitute units of Planck time for the 'infinitesimals' of calculus but that would be of no practical significance. Both views imply that one of the most important features of our existence (extension in time) can correctly be modelled by numbers that can't refer to any real property or 'actual occasion'. Infinitesimals, after all, are infinitesimal while Planck time is defined as the duration required for a photon to traverse the Planck distance, which is nonsensical as a potential description of nature since any photon able actually to measure the Planck distance would be so energetic as instantly to collapse into a black hole, while photons in any case lack inherent durationality and can be used as 'tape measures' for time only indirectly, via their wavelengths and/or observation of events mediated by them.

There are, in other words, many unanswered questions that need to be asked about the origins of duration (see e.g. Raymond Tallis, 2017 or Unger and Smolin, 2015) but current mathematical models can't directly be referring to any physical reality; only to metrics relating to outcomes of observations of relations between realities. Current models may own no more than an illusory validity in relation to what is actually going on as 'time' unfolds - as is becoming ever more apparent from the need to add vast 'epicycles' to cosmological theory in the form of dark energy and dark matter in a manner very reminiscent of the epicycles required by pre-Copernican astronomy. I want to look first at what may actually be responsible for the dynamics attributed to these mysterious entities and then see whether a possible answer to the puzzle can throw light on the 'experience' part of Whitehead's aphorism. We need to put current mainstream concepts of time 'through the looking glass' in order to find a truer picture of the flow of 'actual occasions' with their associated 'experience'.

2. Durationality

It's arguable that the huge mismatch (of some 120 orders of magnitude!) between calculations of vacuum energy and its most likely manifestation (in so-called 'dark energy') opens a window into this topic. One can suppose that the calculation relates to the total vacuum energy of an Einsteinian 'block universe', while this is restricted in the actual universe and 'doled out', so to speak, in durational slices. The implication here is that durations have their origin in the temporal component of the Heisenberg time/energy uncertainties that 'allow' existence of virtual particles,

whose totality over the entire history of the universe underpins the grossly inflated vacuum energy calculation.

The picture of what is going on requires acknowledging that virtual particles may own durations too short to achieve definite positions in time and are therefore unable to acquire anything more than imaginary mass/energy or other measurable qualities, despite the attribution to them of real energies in the integral calculations normally used; calculations that lead to the huge mismatch between theory and the actuality of vacuum energy. A very small proportion of virtual particles may be outliers, probabilistically ‘tunnelling’ through this durational barrier and thus able to manifest in the Casimir effect, but the vast majority are denied ‘actual existence’.

The durational component of their virtuality, however, is viewed as non-infinitesimal and therefore sums to provide an ever increasing expansion of durationality which manifests in space-time expansion. It can be viewed as providing a space-time expansion ‘pressure’ which is opposed by a gravitational contraction ‘pressure’. Very early in the history of the universe, therefore, before durations sufficient to allow ‘actual occasions’ to manifest had appeared, there would have been no contraction ‘pressure’, thus allowing brief appearance of the ‘inflaton field’ of inflation theory, soon to be balanced out by the gravitational mass of actual particles once these had reached a sufficient density. The fact that durational, allegedly ‘dark energy’, expansion ‘pressure’ is increasing again relative to gravitational contraction ‘pressure’ in our current era can be taken to suggest that it isn’t subject to the same, distance dependent, inverse square law that applies to gravity.

Other implications are that durational ‘quanta’ are as ‘real’ as energy quanta but have a reciprocal relation to the latter which cancels out almost all of the energy of virtual particles, confining it to successions of extended ‘presents’. The relationship between durational time and energy can thus be treated as equivalent to that between gravity and momentum in a pendulum as systems ‘swing’ from future to past. We see slices of that time as our ‘present’, actual events within it corresponding to fleeting pendulum momenta at the bottom of their swings.

As far as durational systems are concerned the ‘swing of the pendulum’ is always one way, of course, due to the irreversibility of ‘wave function collapse’ once it has been completed; a process which itself has been shown to be reversible and therefore not¹ (see footnote) instantaneous despite the alleged durational infinitesimality of the Dirac ‘delta functions’ which were at one time supposed to represent the process.

The reciprocity between the two ‘sides’ of measurement processes takes the form that measurers elicit definite outcomes from wave functions while the definite outcomes modify what measurers are likely to elicit from future measurements of systems that will themselves have been modified by establishment of new measurer/measured entanglements. It takes durational time for these mutual changes to establish themselves, as shown by the ‘quantum Zeno effect’ (e.g. Henry Stapp, 2009) in which repeated ‘measurements’ taken sufficiently rapidly produce the same outcome in apparent contravention of the usual probabilistic expectation.

¹ Wikipaedia provides a range of illustrations of collapse reversibility, well worth looking at.

‘Dark energy’, according to this picture, can be regarded as an expression of the limitation of total potential vacuum energy by confinement of its expression to successions of ever-increasing quantities of non-infinitesimal present moments. Can the picture be used to account for that other cosmological epicycle, ‘dark matter’? The answer is ‘yes’ because of the further implication that what can be regarded as local durational *density* differences will exist to which a metric analogous to a temperature scale might be applied; a scale describing local variations in the average durationality of durational quanta in a zone, ranging from the ‘absolute zero’ of ‘all virtual’ to upscaling from the addition of contributions with measurable time/energy uncertainties

On a cosmological scale, out in the wilds of intergalactic space, the bulk of (non-virtual) durational ‘quanta’ will derive from the cosmic microwave background, along with a small contribution from neutrino fields, giving a relatively small durational density over vast volumes. In the neighbourhood of galaxies a range of other sources will provide a higher average durational ‘density’ and thus more durational ‘space’ within which ‘actual occasions’ of all types can manifest and achieve their actuality; manifestations that will enable the standard (general relativistic) consequences for changes in local spacetime curvature. In broad terms dark matter, on this view, is an expression of local increase in the presence of a quantized present because this provides more temporal ‘space’ for totals of ‘occasions of experience’ to occur, independently of the normal, general relativistic, consequences (i.e. relativistic slowing down of clocks in increasing gravitational fields) for *apparent* rates of causation.

Could this picture of the origin of the appearance of ‘dark matter’ in durational density variation have consequences for less than galactic-scale phenomena? It seems to be generally true that the universe has a broadly fractal structure overall, temporally as well as spatially. This is reflected in the current interest in holographic models of it, since all holograms are fractal (though admittedly not all fractals are holograms). Anyhow, it’s a property which might be taken to suggest that our personal ‘actual occasions of experience’ could have origins of a similar nature to those of the universal set. After all the idea that the ‘clock time’ of contemporary physics and the present durations of experience have different, albeit inter-related, origins has been around for a long time (e.g. McTaggart, 1908. Primas, 2003), while it looks as though local variations in durational ‘density’ could be a feature of the universe at all scales. Could durational density differences, here supposed to be responsible for the appearance of ‘dark matter’, have consequences for our own experience? That’s where I’d like to go next, starting with offering a picture of experience-relevant brain activity.

3. Experience and brains

Put in very broad terms, what brains do is to model the dynamics of their social, physical and bodily environments, along with selections of their own activities, then store an ability to recreate particular models when needed; especially when needed in waking life to predict likely outcomes of particular sets of events. Recreation in dreams probably has more to do with getting relatively recent models to ‘fit in’ with those already stored. As Stephen Grossberg (2021) put it,

brains ‘resonate’ with the world. These models are always dynamic happenings, not static structures. Ernst Gombrich, the art critic, made an important point, amply confirmed by neuropsychologists, in emphasizing that even appreciation of entirely static pictures always involves a process of active scanning of them.

Unfortunately the complexities of brain modelling are such that one can give only broad brush accounts of it. Turnbull et al. (2024/2025) have given a nice summary of some of the difficulties involved in trying to be more specific. Relevant features include:

- (a) The existence of at least 50 different neurotransmitters and neuromodulators, many of which affect a variety of receptor types.
- (b) The presence of hierarchies of neural nets, many with ‘small world’ connectivity both within and between hierarchical levels.
- (c) Anatomical variability which includes motility of the tiny dendritic spines that mediate most neural connectivity along with opening and closing of ‘gap junctions’ between cells (including both astrocytes and neurons) and remodelling of entire dendritic structures (which include contributions from astrocytes)
- (d) The recent discovery that many thousands of epigenetically distinguishable cell varieties exist in brains (it used to be thought that there are only a few dozen distinguishable types).

Given these factors, along with the numerous non-linear feedback systems involved, it follows that brain dynamics have to be pictured as originating in a deterministically chaotic system within which memories of every variety, from genetic through episodic to social, provide the ‘attractors’ that shape experience. If turbulent fluid flows notoriously elude detailed mathematical modelling, the complexity of experiential flows is unlikely ever to be captured. Indeed it seems that flows of experience (in its guise as ‘information’) in *artificial* neural net simulations, far simpler than real neural nets, can sometimes already elude detailed modelling. All one can say for sure is that, in brains, flows of experience depend on complex ion shifts with their associated electro-magnetic fields, which in turn are accompanied by energetic events with a wide range of durationality densities from the ‘virtual’ scale up to ones including contributions of 0.1 seconds or more (calculable in principle from the relevant Heisenberg time/energy uncertainties involved).

It follows that patternings of the ‘actual events’ of brain e-m activity will be reflected in their non-commutative relationship to patternings of durational density while particular patternings of both varieties can be perpetuated and recalled via the range of neural memory faculties. In consequence there is an obvious possibility that the patterns of energy manifestation correspond to the ‘objective’ aspect of ‘actual events’ relevant to brains, while patterns of durational density, with the inherent and reciprocal ‘experience’ that each side has of the other in the ‘measurement’ process, correspond to ‘subjective’ aspects. This view carries two implications that are especially relevant to potential tests of its validity.

- (a) Durational density depends on both numbers of energy manifestations and the actual durations involved, which are pictured as having a non-commuting reciprocity with the

types of energy manifestation involved – in general low energy, tightly constrained ‘actual events’ (ion/protein bindings for instance or phonon manifestations) will have larger experiential durations and thus contribute more to durational density.

- (b) The relevant brain models to which energy manifestations contribute are of the content of dynamic state spaces that include contributions from bodies and environments generally. There is no obvious reason to exclude the durational contributions of these from either the average ‘density’ or the ‘reciprocity’ considerations. Any contributions relating to extra-brain sources will usually be small of course (10% or less in the case of direct visual experience - judging by the proportion of synaptic inputs to primary visual cortex neurons that originate directly from retinal sources) but this may not always be the case.

4. Implications

The overall picture offered here shows that subjective models of the world, equivalent to flows of conscious experience, are based on variations in durational ‘density’ having a degree of independence from the objective flows of causality to which the ‘t’ variable of relativistic time applies. If true, the content of subjective experience may sometimes be less tightly tied to that of ‘objective’ neural modelling than might otherwise be predicted. Routine, everyday conscious modelling is always a memory derived anticipation of actual events that have already occurred, either in the environment or within the brain itself. In the case of visual perception, the environment → conscious experience time lag is usually ~0.3 secs (e.g. Benjamin Libet, 1996). A range of perceptual illusions (see e.g. Bachmann et al. 2007) show that conscious modelling of intra-brain neural dynamics is also a latecomer, some of them accompanied by an “I did that” feeling that can itself be illusory, but the time lags involved seem to be quite variable: ranging from about 0.2 seconds in the case of the ‘moving coloured dot’ illusion to several seconds, as one might infer from occurrences of the ‘it’s on the tip of my tongue’ feeling.

If conscious models are indeed a feature of durational structure, however, while brain models are a feature of the flow of energy manifestations there should be occasions when the content as well as the ‘objective’ timing of the two types diverges, basically because the conscious models derive from the reality of durational moments whereas the standard view of ‘objective’ neural models is that they derive from a physics that has no place for non-infinitesimal present moments.

And there is a vast amount evidence that this divergence can and does occur, ranging from aspects of ‘in the zone’ sporting phenomenology, via types of meditational and mystical phenomenology, to near death experiences (see e.g. Steve Taylor, 2024, for an up to date and extensive survey of the range of evidence). However the fact that these experiential anomalies are remembered and reported shows that subjective ‘modelling’, supposedly via patterns of durational density, can and does affect the neural processes and memories responsible for objective modelling. This in turn suggests means of testing and refining more detailed aspects of the picture (Chris Nunn, 2019).

Two principal predictions that can be made from ‘durational density’ considerations are:

- (a) That all general anaesthetics should be found to selectively reduce numbers and energy ‘measurement’ precision of ‘actual events’ occurring in brains – measurement precision is especially relevant to possible refutation of this prediction as it’s already known that anaesthetics reduce overall metabolic activity.
- (b) That brief consciousness-associated apparent violations of energy conservation should be discoverable in brains basically because the model suggests that not all temporal transitions will be ‘smooth’ and therefore that the Noether’s theorem requirement for energy conservation to hold won’t always apply.

The idea that conscious models derive from state spaces larger than those encompassed within brains has far more ‘way out’ implications because it implies that they may modify, or more accurately *modulate*, probabilities of ‘measurement’ outcomes in brain-related environments. Many parapsychology findings are consistent with this ‘prediction’ but one may wonder about potential limits on outcomes.

There is already good evidence, especially from the occurrence of ‘pre-sponses’ (e.g. Daryl Bem, 2011) which appear to involve some form of reverse causation, that there is preservation of topologies from ‘subjective’ to ‘objective’ modelling but not of classical Cartesian co-ordinate connectivity, especially when it comes to temporal positionality. Could ‘subjective’ topologies affect the co-ordinate structure of ‘objective’ ones, and where might one look for clearcut evidence of this?

As this paper started with a piece of science fiction (the ‘Deep Mind’ claim) perhaps it’s appropriate to end up with another. Olaf Stapledon (1930) pictured an extremely advanced society as needing to constantly expend energy to cope with *gravitational* chaos in the solar system engendered by its sophisticated mentality. The model offered here might predict something of the same sort albeit in an extremely localised and presumably very hard-to-detect form. But maybe such effects will turn out to be readily detectable after all; there is surprisingly good though ‘anecdotal’ evidence that unusual, possibly culture-related or culture-enabled, human mental activity can apparently induce gravitational effects, up to and including levitation (e.g. Harvey-Wilson, 2005. Carlos Eire, 2023).

Perhaps the proposal described here is mainly useful for its implication that anomalous findings of all sorts, however crazy they may seem, should be treated as being of potentially much greater evidential value in relation to understanding origins of consciousness than ‘neuropsychology’ often allows. As has been recommended to physicists, we do need to “engage with the [scientific] method not the madness” (Editorial, 2025) if we are ever to fully understand our natures.

There are other theories belonging to the same ‘family’ as the one offered here: causal set theory (e.g. Dowker 2023) for instance allows a picture of the origins of ‘experience’ similar in outline to an ‘actual occasions’ one. Much more closely related is James Reggia’s proposal (Reggia, 2025) for incorporating a temporal position operator into present representations of electromagnetic wave functions by adding an imaginary number term to each of Maxwell’s original four equations; a suggestion that relates to the idea of ‘durational quanta’, conceived in ‘particle

physics' terms, rather as the 'wave' picture of quantum mechanics relates to the familiar wave/particle duality of quantum mechanics. Determining the validity of these approaches, and refining them if valid, would require a focus on physical, as well as experiential, anomalies wherever they may be found.

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